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ORIGINAL ARTICLE

Self–reported eye disorders and visual hazards among Ghanaian mine workers

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Because mining is an important industrial sector in many parts of the world, substantial progress has been made in the control of occupational health hazards associated with it. However, there are possibilities for further risk reduction. A cross-sectional study was conducted at Goldfields (Gh.) Ltd., Tarkwa to find out the prevalence of self reported eye diseases among the miners and visual hazards in the mine using standardized questionnaires. Four hundred and six (406) workers engaged in mining activity were conveniently sampled for the study. They all answered a questionnaire that solicited information on their socio-demographic data, health history, vital eye safety information and eye screening. Tests performed included visual acuity and pinhole examination. Overall, 117 (28.8%) confirmed previous diagnosis of an eye disease with presbyopia as the most reported eye condition in 5.2% of the subjects. While visual impairment was found in 28.1% of the study population only 1.4% reported previous history of refractive errors. Flying dust was named as the potential eye hazard in the mine by 39.7% of the workers. Only 10% of the workers had had some form of eye injuries. Chemical usage was 41.1% among the respondents while 7.9 % complained about intensity of light at the workplace. Eye diseases and visual impairments were reported among miners. Visual hazards were also found in the mine. Eye protection controls should be strengthened and an occupational eye safety and health programmes integrated into the general safety programme of the mine.

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INTRODUCTION

Occupational health is a cross-disciplinary area concerned with protecting the health, safety and welfare of people engaged in a work (ILO/WHO, 2010). Such a programme aims at the promotion and maintenance of the highest degree of physical, mental and social well-being of workers, the protection of workers from risks adverse to health, prevention of ill health caused by working conditions, placement and maintenance of the worker in an environment adapted to his physiological and psychological capabilities (ILO/WHO, 2010). To achieve the above goal among mine workers calls for a multifaceted approach to the job hazard assessment, risk evaluation and health surveillance, including eye examinations.

Occupational vision which is part of the general health assessment is concerned with the efficient and safe visual functioning of an individual within the work environment. It encompasses more than just the prevention of occupational eye injuries, but includes vision assessment of workers taking into account their specific vision requirements and the demand these requirements place on them (Gregory, 1996). Underlining this assertion is the fact that vision is a critical aspect of many jobs (Occupational Vision Requirements, 1994). In Ghana, the legal framework for ensuring health and safety at work places is contained in the Factories, Offices and Shops Act (328) of Ghana, 1970 (Employment and relations centre, Ghana; 2010). The main provisions concern improvements neces-

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sary to attain internationally accepted standard for safety, health and welfare of workers. To prevent the occurrence of eye diseases, mine hazards that are a threat to the eye, needs to be identified. Identification of potential hazards to the eye could lead to the prevention of accidents at the workplace (Cornford, 1970). Although it is impossible to prevent all workplace accidents, the institutional anticipation of hazards is a major step in securing the safety and health of workers. The major hazards against which eye protection will be needed in the workplace are projectiles, chemicals (splashes and fumes), radiation (especially visible light, ultraviolet (UV) and infrared (IR)) and heat (Gregory, 1996). Common projectiles in the mining industry include pieces of screwdriver blade, drill bits, grinding wheel, metal debris, rock, steel rod and dust (Donoghue, 2004). Projectiles cause injuries like corneal or conjunctival abrasion and foreign body sensation penetrating eye injury, blunt trauma and some being toxic to the eye.

The mining activity also often makes use of hazardous and carcinogenic chemicals which can be acidic, alkaline, organic solvent and surfactants. For instance, sodium cyanide used in mining is thought to cause eye redness and pain, mercury poisoning causes damage to the central nervous system, endocrine system and kidney with its attendant effects on the visual system (International Chemical Safety Cards; 2008; Canadian centre of occupational health and safety, Canada; 2009). Again acrylamide exposure causes slight injury to the eye, irritation, sleepiness, and dizziness (The Minerals Council of Australia, 2002). Long term (chronic) exposure to radiation for example has been associated with the development of cataract (Pitts, 1993). Poor vision has been related to improper or inefficient lighting, contrast, working distance, viewing time and poor design of the work environment (Gregory, 1996) which potentially causes occupational injury due to eye fatigue and limits productivity. For example, close precision work has been associated with loss of far visual acuity.

Axial elongation of the eyeball, extraocular muscle tension, increased intraocular pressure (IOP) and increased lens power are all interrelated mechanisms that can affect visual acuity in long-term close work like mining (Browler *et al.,* 1991). Prolonged near work can also stress accommodation such that workers with low accommodative amplitude or flexibility will complain of asthenopia, fatigue, diplopia, watering and blurred vision due to convergence insufficiency (Gong *et al.,* 2003). The use of eye protection devices is required to prevent exposure to the eye at the workplace. The eye protection chosen for specific work situation should depend upon the nature and extent of the hazard present, the circumstances of exposure, other protective equipment used, and personal visual needs (National Institute for Occupational Safety and Health, 2010). The eye protection should also be adjustable to fit the individual, allow peripheral vision, be comfortable and possibly correct for the worker's refractive error. Personal eyewear recommended for miners include goggles, face shields, safety glasses and full-face respirators (Goldfields International Ltd, 2008).

The role of poor vision in causing accidents at mine sites, the occurrence of eye diseases either caused or exacerbated by the exposure to mine hazards like chemicals, heat and dust, and the ramification that mining related systemic diseases have on the visual system have not well been investigated. This present study was therefore an attempt to document reported eye diseases and visual impairment among miners and potential hazards to the eye.

MATERIALS AND METHODS

Sampling

A cross-sectional descriptive study was conducted. A section of the study population actively involved in mining and processing were conveniently sampled to represent the mine workers at Goldfields Ghana Limited, Tarkwa. Using the expression $n = Z^2 (1 - p)(p)/b^2$, (where n = minimum sample size, p = anticipated prevalence [assumed to be 50%], b = desired error bound taken as 5% and Z = the standard score at 95%), a minimum sample size of 314 was calculated, this was however increased to 406 to account for attrition rate.

Procedure for data collection
A structured questionnaire was used to solicit respondents socio demographic data (age, sex, etc), previous and current work history, workstation, medical history, current use and type of mediation, the use of industrial grade protective eye wear, any eye injury sustained, nature of work and associated hazards, and their general impression and opinion about safety at their workstations. Participants who had low educational background or for some other reason could not fill the questionnaires were assisted by reading and explaining it to them whiles those who could read and understand were given the opportunity to take the questionnaires home and return next day with it for the eye examination. Out of a total of 500 questionnaires distributed, 406 were recovered and evaluated for onward analysis.

All the 406 respondents had their visual acuity (VA) taken. Information obtained from observing events at the mine was used to supplement and corroborate data from the questionnaires and interviews. A critical evaluation and examination of the mining site was undertaken by the researchers in the form of a tour at the mine to ascertain the presence of potential hazards to the eye. Conscious attempts were made to observe precautionary measures that were in place to prevent accidents and protect the eyes. Informal interviews were held with some key persons who by reason of their official position could respond to some of the information collected during the questionnaire administration. The results of the visual acuity test, data collected from respondents and observations and interviews formed the basis for analysis.

Ethical Consideration
Institutional approval to carry out the study was obtained from the Management of the mines and the Department of Optometry, University of Cape Coast and individual workers before the commencement of the study. A research consent form was given to each participant for completion and those who required assistance were offered the necessary help by the researchers. The workers were adequately informed that participation in the study was voluntary and that they were free to withdraw from participation at any stage.

Data management and analysis
The data obtained from the questionnaires was crosschecked from different sources within the mine and per interview with officials to establish their veracity and authenticity or otherwise. This helped minimize bias on the part of the respondents. Entry visual acuity (VA) of 6/9 or worse in the better seeing eye was recorded as a visual impairment (WHO, 2004). The cut off VA (6/9) was used because mining is a visually demanding job and workers need an accurate vision to prevent accidents. In all comparisons, a p value less than 0.05 was considered statistically significant. Data obtained were analyzed using the Statistical Package for Social Sciences (SPSS v 15).

RESULTS

General characteristic of the studied population
Out of the 500 questionnaires a total of 406 (81.2%), responded representing an attrition rate of 94 (18.8%). Of the 406 respondents, 374 (92.1%) were males and 32 (7.9%) females. The mean age of the respondents was 41.1 years (range = 20 – 61, SD = 8.9). Majority of respondents fell within the age range of 41-50 (40.6%), followed by 31-40 (29.3%), then 21-30 (14.8%), 51-60 (14.0%) and 61 -70 (0.7%). The least recorded age range was 'less than 21' (0.5%), an indication that most of the workers were middle aged.

Visual acuity assessment
All 406 subjects had their visual acuities measured (Table 1). This was recorded as habitual visual acuity taken with or without their spectacle prescriptions. Twenty three individuals representing 5.7% were wearing glasses and therefore had their VA taken with their spectacles on. Three hundred and eighty three (383) of the 406 (94.3%), however had their VA taken without any aid. Significant visual impairment (VA ≤ 6/18) was observed in 12 (3.0%) individuals and moderate impairment (VA ≤ 6/9 - 6/12) in 102 (25.1%) (WHO, 2004). The results showed that the majority (292/406; 71.9%)

of the workers had normal visual acuity of 6/6 or better. There were 142 (35.0%) individuals who came under fairly poor distant vision range of 6/9 to 6/12. Eleven (2.7%) workers came under category one (VA ≤ 6/18 - 6/60) of the World Health Organization (WHO, 2004) grades of visual impairment. There were however 5 (1.2 %) persons who qualified as blind in at least one eye. Notably, one worker had a vision of counting fingers at 2 metres (CF@ 2M) in the better eye and interestingly had no spectacle correction for his impairment. Visual impairment was found in 114 (28.1%) of the respondents.

Reported eye diseases and disorders

Table 1: Distribution of Visual acuities in the worse and better Seeing Eye

Visual acuity	Worse eye	Better eye
6/5	156 (38.4)	231 (56.9)
6/6	57 (14.0)	61 (15.0)
6/9	121 (29.8)	83 (20.5)
6/12	21 (5.2)	19 (4.7)
6/18	29 (7.1)	10 (2.5)
6/24	8 (2.0)	0 (0.0)
6/36	3 (0.7)	1 (0.2)
6/60	5 (1.2)	0 (0.0)
3/36	1 (0.2)	0 (0.0)
CF@ 1M	1 (0.2)	0 (0.0)
CF@ 2M	2 (0.5)	1 (0.2)
CF@ 3M	1 (0.2)	0 (0.0)
Total	406(100)	406 (100)

CF = Counting fingers

Previously diagnosed eye diseases were reported by 117 (28.8%) compared to 289 (71.2%) workers who did not report of any previously confirmed diagnosis. The relationship between the reported eye diseases and sections of work was not statistically significant (χ^2= 16.1, p= 0.64). However, the majority (81.2%) of the cases came from the, mining, engineering, mineral resources and the metallurgy departments. Presbyopia (reading difficulty), 21(5.2%), was the most reported condition among the workers with only about half of them having spectacle correction. Though there was also no statistical significance (χ^2 = 37.9, p= 0.66) between the total mining experience of workers and the eye conditions reported, majority of the cases were reported among workers who had mining experience between 1-15 years. Table 2 shows the types of eye conditions reported. For 76 (65.0%) individuals, the confirmed date of diagnosis of the eye conditions was within the last five years, 19 (16.2%) between 6 -10 years, 4 (3.4%) in 11-15 years and 2(1.7%) cases had occurred in the last 16 -20 years.

Diagnosed medical conditions were also reported by the workers. One hundred and twelve (27.5%) confirmed a previous history of systemic disease whilst 289 representing 71.1% did not. Overall, hypertension was the most reported in 51 (12.7%) subjects. Others were musculoskeletal pain 7 (1.7), malaria 14(3.4), diabetes 5 (1.2%), respiratory tract infections 5 (1.2%), asthma 4 (1.0%) and hearing problem 2 (0.5%), HIV/AIDS 1(0.2%) and diarrhea 4 (1.0%). There was no statistically significant difference (p= 0.525) between the reported systemic conditions and the number of years the respondents have worked in a mining industry.

The use of eye protection and reported eye injuries

The main form of eye protection used on the mine was plastic goggles. These goggles were provided in plain and dark tinted colours, for day and night use. When inquired about their use of eye protection, 276 (68.0%) responded in the affirmative whilst 130 (32.0 %) did not use any eye protection in their work. Out of the total number of respondents who used eye protection, 199 workers representing 72.1% said the eye protection they use protected them adequately, 74 workers accounting for 26.8% said they did not receive adequate eye protection from the eye protective device they wear. The chunk of the workers who use eye protective devices varied greatly among the sections (χ2= 120, p < 0.01). The mining, engineering, metallurgy and mineral resources departments had 111 (40.2%), 70 (25.4%), 36 (13.0%) and 26 (9.4%) individuals using goggles respectively. The remain-

ing six sections together had only 33 (12.0%) workers using eye protection.

On whether the eye protection devices provided by the company was appropriate for the kind of work they do, 231 (81.1%) out of the total of 285 workers responded affirmatively while 54 (18.9%) responded in the negative. Quite a number of those who agreed on its appropriateness maintained that protective devices are provided by the company and they did not have any requisite knowledge to evaluate them. Eye safety and precautionary measures seemed to be very effective in preventing eye injuries as only 40 (10.0%) of 402 individuals had had any form of eye injuries as compared to 362 (90.0%) who had not suffered any eye injury at the mining site. Notably, only 5 (12.5%) of those who reported eye accidents were using eye protection when their eye injury occurred. The remaining 35 (87.5%) were not wearing eye protection. The relationship between the use of eye protection and the occurrence of eye injuries was significant ($\chi 2 = 7.77$, $p = 0.05$).

Visual hazards

The workers reported the use of one or more chemicals at their workstations. While 166 respondents, representing 41.1% of the workers either work with or were exposed to chemicals in the mine, 238 representing 58.9% of the sample population were not exposed to any chemicals. The use of chemical was significant among workers of different sections ($\chi^2 = 92.4$, $p \leq 0.01$). This was more prominent in the mining, metallurgy and engineering (process) sections with 142 individuals (85.5%). Overall, cyanide (15.8%) came up top as the chemical most individuals were exposed to followed by acids (14.3%),ammonium nitrate (11.1%). Caustic soda (5.4%), carbon (2.5%), anfull (6.4%), emulsion (4.7%) and other explosive chemicals were fairly used. Other chemicals mentioned were silica, borax, lime, flux, lead, electrical solvents and degreasers, xylene, hydrogen peroxide, reagents and other alkaline. Other chemicals that were not indicated represented 10.2%.

The mine scored high marks when workers impres-

Table 2: Distribution of eye diseases reported by the studied population

Eye condition	Distribution (%)
Normal	201(49.5%)
Cataract	6(1.6%)
Presbyopia	21(5.2%)
Refractive error	19(4.7%)
Conjunctivitis	18(4.4%)
Trauma	9(2.2%)
Glaucoma	7(1.7%)
Photophobia	8(2.0%)
Other(s)	26(6.4%)
Pterygium	3(0.7%)
Undetermined	88(21.7%)

Table 3: Distribution of the potential visual hazards among the studied population

Visual hazard	Distribution (%)
Dust	161(39.7)
Heat	8(2.0)
Intense light	32(7.9)
Chemicals	93(22.9)
Dim/ dark environment	4(1.0)
Don't know	50(12.3)
Wielding light & sparks	11(2.7)
Computer rays	8(2.0)
Smoke	4(1.0)
Other(s)	15(3.7)
Machinery	5(1.2)
Falling objects	15(3.7)

sion about the lighting condition on the mine at night and in their offices and stores were ascertained. Apart from five respondents who abstained from that assessment, 316(78.8%) workers gave thumps up to the lighting conditions at the mine. However, a significant group of 85 representing 21.2% were not happy with the lighting conditions mainly because of tower light intensity at night, complaining that it either affected their vision or they could not tolerate it.

There were a number of identified hazards in the mine that were of potential threat to the eye (Table 3). Dust was named as the most potential threat to the eye by the miners for which eye protection was needed. One hundred and sixty one who took part in the study representing 39.7% named dust as the most present visual hazard in the mine. Chemicals were named second by 93 respondents with a percentage score of 22.9%. Fifty (12.3%) workers did not know or were not aware of the presence of any visual hazards in the environment while other potential visual hazards recorded 4.9%. When quizzed about their general impression of eye safety in terms of enforcement by management and adherence by workers, overall, 219 of 399 (54.9%) rated it as good, 61 (15.3%) rated it very good and 54 (13.5%) as excellent. Forty five individual representing 11.1% rated the mine eye safety standards as fair, and the least rated was poor by 20 individuals with a percentage of 5.0%.

DISCUSSION

Prevention of the eye from exposure to hazards and injuries is part of the field of occupational safety which can be carried out in the most clear-cut manner. Eye injuries in the workplace however continue to be major cause of morbidity and disability, despite well publicized standards for industrial eye protection. The research sought to undertake eye risk assessment and map up solution patterns by recommending appropriate remedies which when applied will help control preventable occupational eye injuries and disorders; the driving force behind this present study.

Visual examinations in this study were carried out by adopting recommended standardized test procedures, similar to those seen in other studies. The results must however be carefully be extrapolated since the background and hazards in other mining and industrial settings might differ from what pertains at Goldfields, Tarkwa (Desai *et al.,* 1990; Yoruk *et al.,* 2008; Okoye and Umeh, 2002; Abiose and Umeh, 1980; Davies *et al.,* 2007). The mean age of workers in the study was higher than that found in other industrial establishments in Saharanpur, Turkey and Germany (Yoruk *et al.,*2008; Titiya and Murthy,1998; Nicaeus *et al.,*1996). The much older workforce in the mining industry may be due to the ageing population of the country and the fact that the main occupation in the Wassa-West District (Tarkwa) is mining so most of them stay on the job till they retire (Mba, 2010). Majority of the workers (mine workers) had essentially normal visual acuities (Table 1) indicating that the hazards of the working environment have had little impact on the visual status of the workers. However, future visual implications can be far reaching as disorders such as pterygium, cataract and chronic conjunctivitis could potentially obstruct vision at a later stage resulting in needless impairment of vision or blindness (Shields and Sloane, 1991; Akabzaa and Darimani, 2001; ARICANEWS, 2000).

The eye disorders reported in this study (Table 2) were common to those found in studies in other industrial establishments in the world since the risk factors of exposure to ultraviolet radiation and dust were common. (Desai *et al.,* 1990; Yoruk *et al.,* 2008; Okoye and Umeh, 2002; Abiose and Umeh, 1980; Davies *et al.,* 2007). More prominent were diseases caused by carcinogenic and irritant substances and exposure radiations such as cataract, pterygium and chronic conjunctivitis. The mine workers come into direct contact with the visual hazards comprising projectiles and falling objects, dust, chemicals, machinery, heat, intense illumination, smoke, heavy computer usage, and dim/dark room (Table 3). This could have contributed to the prevalence of ocular injury and foreign body sensation recorded in this study especially among technical sections namely mining, engineering, metallurgy and mineral resources departments. There is therefore the need

to wear protective eye devices at all times. The workers should understand the need for safety as the majority has attained at least an intermediate level of education.

Although, an appreciable 67.7% of respondents wore eye protection, some inadequacies regarding the use of ocular protective wears were identified which serves as barrier to ocular protection (Lombardi *et al.,* 2009). Some protective goggles did not fit well allowing fumes, dust and smoke to enter their eyes. Some miners also did not use their eye wear frequently while others complained that their damaged or loss wears were not replaced on time, forcing them to work without protection. The substantial use of protective eye wears reflected considerably, low prevalence of injury recorded in this study. The use of eye protection has been found to contribute substantially to the prevention of eye injuries. (Okoye and Umeh, 2002; Nicaeus *et al.,*1996; Lye, 1995; De la Hunty and Sprivulis, 1994;.Frobose and Gruntzig, 1984; Vasu *et al.,*1990 (Occupational Vision Requirements, 1994).

Nevertheless, there is a need for a strong advocacy and worker education to record a reduced or zero eye accidents at the mine. It was noted that the mine had a standby emergency and first aid team, but it was found that there is no eye first aid personnel among the team. The safety and health training of the mine safety officers were also devoid of eye safety educations. This is against the background that providing eye first aid for injuries involving sensitive parts of the eye such as the cornea ensures re-epitheliazation and comfort in corneal abrasions and prevents visual impairments as a result of injuries sustained (Peate, 2007). A well equipped eye safety tray should contain topical anaesthetic, fluorescein dye, foreign removal spud, a short acting mydriatic agent and antibiotics.

Potential visual hazards identified in the mine were projectiles and falling objects, dust, chemicals, machinery, heat, intense illumination, smoke, heavy computer usage, and dim/dark room. Goldfields (Gh.), Tarkwa was recertified to the new occupational health and safety advisory services (OHSAS) 18001:2007 standard by the Bureau Veritas in 2007 due to its commitment to the safety of its workers (Goldfields International Ltd, 2008). The mine also operates an occupational health and safety policy which provides strategic guidelines as to the intent and action required by each miner throughout the organization. The low scale of injuries affirms the assertion that Ghanaian large scale mines are among the safest in Africa and the world at large (Agbesinyale, 2003).

CONCLUSION

From the study we concluded that there appears to be occupationally related eye diseases and disorders among the mine workers at Goldfields (Gh.) and also confirmed that there are visual hazards in the mine against which eye protection is needed. Generally however, the mine has a good rating as far as eye safety is concerned as expressed by the miners overall impression of management attitude and their adherence to eye safety and precautionary measures. Based on the findings, we recommend the education of managers, workers and purchasing officers on eye safety and its tenets the vigorous enforcement and use of effective eye protective wear in high-risk areas in the mine.

COMPETING INTERESTS

The authors declare that they have no competing interests.

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